INTRODUCTION

The musculoskeletal injuries account for 10 to 15% of childhood injuries. In younger children, injuries are related to falls or intentional physical abuse, however in older children and adolescent sports injuries and motor vehicle accidents predominate. Due to the anatomic and physiologic differences between skeletal structures of children and adults, it is very important for the Emergency Room physician to realize that a serious growth plate injury can occur in a child without any radiological changes.

GENERAL PRINCIPLES

A. A careful history and physical examination will predict the x-ray findings with great accuracy.
B. If x-ray findings are normal but patient clinically has sustained major trauma, treat as a fracture.
C. The neurovascular competence should be checked before and after reductions.
D. Most orthopedic injuries can be predicted by knowing the chief complaint, age of the patient and mechanism of injury.
E. Be familiar with proper x-ray views and never accept inadequate x-rays.
F. Always get x-rays before reductions unless it is limb threatening.
G. Remember RISE
   R - Rest to the injured extremity
   I - Apply ice for the swelling to subside
   S - Splint and immobilize
   E - Elevate the injured extremity
H. Circumferential casting should never be done by Emergency Physician due to malpractice reasons.
I. Patient should be checked for their ability to ambulate safely before being discharged from the Emergency Department. If in doubt admit the patient.
J. All patients should receive after care instructions typed if possible before discharge.
K. In a Multiple Trauma Victim the life threatening injuries should be treated before the non-critical orthopedic injuries.
L. While contacting the orthopedic surgeon all injuries and fractures should be precisely described.
M. While obtaining x-rays of Fractured Extremity always include joints above and below the site of injury and get comparison view of other extremity if indicated.

The Anatomic and Physiologic Differences between Musculoskeletal System of Children and Adult.

The infants and young children have less ossified tissue, wider epiphyseal plates and thicker periosteum than older children and adolescents. Furthermore, the children's bones are more porous and bendable. In utero the bone develops from mesenchymal tissue subsequently bony structure. The physis or cartilaginous plate contains the germinal chondrocytes which
by reproducing themselves cause the bone to increase in length. While enchondral ossification with germinal layer proliferation of the physis causes the bone to lengthen, the membranous ossification in the periosteum enlarges the bone circumferentially causing an increase in diameter. The periosteum in children is thicker than in adults. Due to the anatomic and physiologic differences, children's bones are more susceptible to stress, buckle, greenstick fractures and growth plate injuries. The Salter Harris Classification of Growth Plate Injury The growth plate fractures involving Epiphysis and Metaphysis account for 15 - 20% of childhood fractures and is described by Salter-Harris. The Salter-Harris Type I Fractures extend through the physis, not displaced, not visible radiologically and clinical diagnosis is generally based on swelling and tenderness over the physis. Type II Fracture involves Epiphysis and fragments of Metaphysis, the most common childhood physeal injury, and is generally treated by reduction and immobilization for 3 - 4 weeks. Type III Fractures are transverse along Physeal-Metaphyseal junction and extends through epiphyseal ossification, center, and articular cartilage. This is an unstable fracture requiring good alignment. Type IV Fractures involves Epiphysis, Metaphysis growth plates and Diaphysis and needs surgical intervention. Type V Fractures are generally the crush injuries involving growth plates and the bone. Terminology and Classification The fractures can be described, categorized and presented according to: 1) Anatomic Location; and 2) Direction of Fracture Line. A. The Anatomic Location Fractures are usually described as involving the Proximal, Middle, or Distal thirds of a long bone. The other anatomic terms frequently used are head, shaft or base of Metacarpals or Metatarsals. B. Direction of Fracture Lines Transverse - Fracture line running perpendicular to the bone. Oblique - Oblique fractures run across the bone at an angle of 45 to 60 degrees. Spiral - A spiral fracture has a torsional component. Comminuted - A comminuted fracture involves more than two fragments. Impacted - The ends of impacted fractures are compressed together. These are generally stable fractures. C. Relationship of the Fracture Fragments to Each Other Alignment - This is the relationship of the axis of fragments of long bones to one another. Alignment is described in degree of angulation of the distal fragment in relation to the proximal fragment. Apposition - This describes the contact of the fracture surfaces which may be partial. If the fragments are not only displaced but also overlapping the term is called Bayonette opposition frequently seen in femoral shaft fracture. Stability A stable fracture does not have a tendency to displace after reduction. Unstable Fracture - A fracture that displaces after reduction. Associated Soft Tissue Injuries Closed Fracture - A fracture in which the overlying skin remains intact. Compound or open fracture where overlying skin is broken. Complicated Fracture - A fracture that is associated with either Neurovascular, Visceral, Ligamentous or Muscular damage. Intra articular fractures are usually complicated. Uncomplicated Fractures are usually associated with minimal soft tissue injury. Mechanism of Injury It is very important to know the impact of injury such as: Direct Force - Usually causes transverse, oblique or comminuted fractures. Indirect Forces - Traction on a ligament attached to a bone can result in an avulsion fracture. A valgus stress at knee can result in compression or depression fracture of tibial condyles. Dislocation, Subluxation and Diastasis Joint injuries frequently associated with fractures are generally described as: Dislocation - Where there is total disruption of the joint surfaces with loss of normal contact between the two bony ends. Subluxation - Partial disruption of a joint with partial contact between the two bones that make up the joint. Diastasis - A disruption of the intra osseous membrane connecting
Management of Upper Extremity Trauma

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the two joints. Clinical Features of Fractures The swelling, pain, tenderness, are the
frequent clinical findings at the site of fracture. A gross
unstable fractures and should be splinted immediately to
Bleeding is a common problem with most fractures. The Average Blood Loss with
a Closed Fracture Fracture Site Amount Radius and
Ulna 150 - 250 cc Humerus 250 cc Pelvis
1500 - 3000 cc Femur 1000 cc Tibia
and Fibula 500 cc Musculoskeletal Pain Following Trauma
Physical Examination Localized Tenderness
Swelling Impaired Function Yes No
X-rays Exam Symptomatic
Treatment Positive Negative Reevaluate in
5 - 10 Days Improved? Orthopedic
Immovilize with Consultation Splint or Cast Yes No Orthopedic
X-rays and Treatment as Fracture
Evaluation Follow up as Reevaluate in
Needed 5 - 10 days Yes No Repeat X-rays Orthopedic
Consult Orthopedic
The purpose of Emergency Splinting and Bandage The purpose of
management of Orthopedic trauma. Emergency Splinting are:
1. To prevent further soft tissue injury by the fracture fragments.
2. Pain relief. 3. Lower the incidence of fat embolism. Any unstable fracture
must be stabilized by external splinting before patient is transported to x-
rays. In the
Emergency Department, casting is usually delayed 24 - 48 hours until swelling subsides. All
dislocations should be splinted using the bone above and bone below the joint. All fractures
should be splinted in position of function. The guidelines for splinting traumatized
extremity: 1. Use splint of appropriate size and shape. 2. Avoid applying circular rigid
splint or cast which increases the chance of compartment syndrome. 3. Pad all the
bony prominences to avoid pressure necrosis. 4. Wrap the splint loosely not too tight with
Ace wrap. 5. Give adequate after care instruction. The fractures with obvious
deformity are limb threatening injuries and look for signs of Pallor, Paresthesia, Pulseless,
Palsy, Pain in distal end, if these are present then immediate reduction traction are done
before splinting. There are different types of splints available to stabilize the injured limbs.

Inflatable splints are particularly useful in pre-hospital setting. Soft splints such as Jone's
dressing, pillow splints, figure of eight, clavicular strap. Rigid splints made of Webril Pade
and plaster. Mast trousers especially used to stabilize femoral fracture. Long arm or
short arm splints. Posterior arm splints for elbow and forearm fractures. Special types of
hand and wrist splints such as ulnar gutter splint for fractures 4th - 5th metacarpal.
Dorsal extension splints for non-rotated finger injuries involving phalanges, IP joint. Thumb
spica splint or cast for fracture scaphoid. Immediate orthopedic referral should be made for
any significant injuries, obvious deformities dislocations or open fractures. The child should
also be treated for any other injuries sustained. Long Term Sequelies Fractures in
children frequently lead to growth arrest and growth failure if not treated adequately. Other
problems include non-unions usually with Salter III and open fractures. Avascular necrosis
may complicate an injury that disrupts blood supply. Angulation deformities might result from
improperly managed greenstick fractures, bowing fractures and Salter II, III, IV injuries. A
longitudinal growth deformity might result from inadequately treated Salter III, IV fractures.
Open fractures often leads to bone infections, joint stiffness and post traumatic arthritis.

**MANAGEMENT OF FRACTURES OF UPPER EXTREMITIES**

**Clavicle**

The clavicle is the most common bone fractured in children and can be treated easily by figure of eight clavicle strap. Fracture Proximal 3rd clavicle results from blow to anterior chest area. Fracture Middle clavicle is the most common type of fracture seen in almost 80% of clavicle fracture and results from fall. A direct blow to top of shoulder leads to fracture distal third clavicle. The child presents to Emergency Room with pain aggravated with upper arm movement, swelling, tenderness, crepitus at the site, the arm is usually kept downward close to the body. After performing a complete physical and neurovascular examination, a shoulder sling should be applied before patient is sent to X-ray Department, and pain medication should be given. The uncomplicated fractures of clavicle are treated with figure of eight bandage for 3 - 4 weeks which helps in keeping the shoulder in abduction. The complicated fractures, sterno clavicular dislocations, acromio clavicular separation should be referred to Orthopedic Surgery.

**Shoulder Injuries**

Shoulder injuries are common during vigorous athletic activities in adolescents and older children and patients generally present to Emergency Room with:

1. Shoulder contusions.
2. Fracture humeral heads.
3. Acromio clavicular separations.
4. Anterior and posterior shoulder dislocations.

**Shoulder Dislocations**

The dislocation of humeral head from glenoid cavity is more frequent in adolescent resulting from serious, vigorous trauma to shoulder generally during sports activities. 95% of dislocations are anterior and results from indirect trauma to the arm causing abduction and extension of the shoulder disrupting the joint capsule. The posterior shoulder dislocations are injuries seen in Newborns with birth trauma and shoulder dystocia, and in epileptic patients secondary to fall on adducted arm.

Physical examination of patients with anterior dislocation reveals obvious deformity of the shoulder with flattened deltoid muscle, prominent acromion and palpable humeral head anterior, medial or inferior to glenoid. There is limited range of abduction and external rotation of arm. Hyposthesia over deltoid muscles result from axillary nerve injury. Recurrent shoulder dislocation associated with glenoid Labrum tear and compression fracture of posterior humeral head is condition called Hill-Sachs Lesion.

Management After having stabilized the patient with shoulder sling, pain control, x-rays should be obtained including anteroposterior, lateral and axillary views and orthopedic consultation should be made. The reductions are generally done under sedation with traction, countertraction technique. Fractures of Humerus Patients with proximal humeral fractures present to Emergency Room with pain, swelling, deformity of upper arm usually after having fallen backward with arm extended. Children and adolescent with shoulder injuries generally have Salter II epiphyseal separation of proximal humerus. Most fractures of proximal humerus are treated with sling and swathe until union occurs. More severely displaced fractures need surgical correction.

**Fractures of Humeral Shaft**

These fractures result from direct blow or indirect trauma from falling on outstretched hand. Spiral fractures of the humerus in newborn suggest birth trauma, in older babies suggest physical abuse. Radial nerve injury frequently results from fracture humerus resulting in wrist drop. These fractures in children heal very fast and external support with plaster splints for several weeks usually hold upper arm stable enough for union to occur.

**Supra Condylar Fractures of the Humerus**

Children with supra condylar fracture humerus present to Emergency Room with severe pain, swelling deformity around elbow with impaired distal circulation to the forearm and wrist. The distal fragments of humerus is pushed posteriorly leading to damage of brachial artery and median nerves
leading to compartment syndrome and Volkmann's Contracture to the limb. Clinically the most significant sign of ischemic myositis is pain in forearm, aggravated by fingers extension, numbness and paresthesia, pallor and cyanosis of the fingers. An immediate orthopedic consultation should be made and these patients are generally admitted for observation and surgical treatment of the fracture. Elbow Injuries in Children These injuries are very common in children due to direct or indirect forces and if not recognized or treated early might lead to growth disturbance, deformity, neurologic impairment and joint stiffness. The common elbow injuries are: A. Fracture of the capitellum. B. Epiphyseal separation of medial humeral epicondyle. C. Fracture of medial humeral condyle. D. Fracture of olecranon. E. Fracture of neck of radius. F. Posterior elbow dislocation. Children with fractures of the capitellum generally have Salter IV epiphyseal injuries which need surgical correction in order to avoid severe cubitus valgus deformity and joint contractures. Fractures of medial humeral condyle though rare in children, have the potential for producing cubitus varus deformity if not treated adequately. These fractures need open reduction and internal fixation if there is impingement on ulnar nerve. Radial neck fractures need open reduction if there is angulation more than 30°. Most of the elbow injuries are treated with rest, sling, ice, pain control, elbow aspiration to relieve hemarthrosis and orthopedic referral. Subluxation of Radial Head or Nurse Maid's Elbow This is a common injury seen in children 6 months to 5 years of age and results from tear of periosteal attachment of the annular ligament that holds the radial head with proximal ulna and capitellum. Typically the parent or baby sitter has pulled the child by arm with arm extended and pronated. The child presents to Emergency Room with pain, arms pronated, slightly flexed and close to the body and unable to move the arm. One can reduce the subluxation by supinating the forearm while extending the elbow and then flexing. A reduction clip heard can be felt if thumb is placed over radius head during reduction. The child can usually move the arm freely after the procedure. Fractures of Forearm and Wrist These are most common fractures seen in pediatric age group. The diagnosis is made easily over the extremity and confirmed by x-rays. Simple undisplaced fractures like minor buckle fracture of radius or torus fractures can be treated by applying well molded short arm cast and discharged home. Displaced fractures of radius and ulna with over 30° angulations usually require reduction by orthopedic surgeon. More severely displaced fractures usually need aggressive treatment. Child with severely displaced fractures of radius and ulna needs hospitalization, reduction and stabilization under general anesthesia. A green stick fracture involving one cortex area only might need manipulation to break through both cortices to prevent re-angulation. Fractures of distal radial physis with dorsal displacement of the epiphysis are common injuries seen in adolescent and children and are treated by reduction and casting. Monteggia Fracture These injuries result from fall on outstretched hand. The hyper pronation when truck and humerus rotate externally after the hand is fixed on the ground can cause fracture of ulna with radial head dislocation. The child present to Emergency Room with pain, swelling, tenderness of forearm with restricted range of motion elbow joint. Radiological investigation should always include x-rays forearm with wrist and elbow. Management Reduction of radial head dislocation and ulnar fracture should be done by orthopedic surgeon. Supination, traction and direct pressure on radial head with elbow flexed 90° generally reduce the dislocation. The elbow is splinted in flexion and repeat x-rays are made to document the reduction. Galeazzi Fracture involves break at the junction of middle and distal third radius with disruption of distal radio ulnar ligament.
Colles' Fracture is a transverse fracture of distal radius with dorsal angulation and loss or reversal of volar tilt to the distal radial articulating surface. Patients might have accompanying fracture of ulnar styloid or Salter II epiphyseal injury. Smith's Fracture is reverse Colle's Fracture caused by blow to the dorsum of wrist or distal radius with forearm in pronation.

Management Treatment depends upon the type of fracture and alignment. Angulated fractures greater than 15 degrees in children lead to decreased function. Generally fractures are immobilized for 4 - 6 weeks. Wrist and Hand Injuries Since hand is the most frequently injured part of the body, physicians should be aware of common wrist and hand injuries. As mentioned before a good history and physical examination of the injured site with adequate radiological investigation will lead to proper management of the injury.

Fractures of Wrists Since carpal bones are largely cartilaginous in growing years, carpal fractures are rare in children and mostly result from extension injuries to wrist. Navicular Fractures The scaphoid is most frequently injured bone resulting from fall on outstretched hand. Child complains of pain along distal radius, swelling and tenderness are noted at anatomic snuff box and x-rays of wrist including navicular view confirm diagnosis. Treatment Non displaced fractures require immobilization for 6 - 10 weeks with thumb spica cast. Lunate and perilunate dislocations are injuries resulting from fall on outstretched hand. Diagnosis is confirmed by x-rays where the normal alignment formed by 3rd metacarpal, capitate, lunate and radius is disrupted. These injuries should be referred to orthopedics. Game Keeper's Thumb This injury results when skier falls on outstretched hand while grasping the ski pole. The hyper extended thumb with ulnar collateral injury often is associated with Salter III fracture of proximal phalanx thumb which needs open reduction and pin fixation to avoid angular deformity of thumb. Bennett's Fracture is fracture at base of 1st metacarpal with dislocation of one of the fragment. An uncomplicated ulnar collateral injury at base of thumb is managed by thumb spica cast for 6 weeks. Fracture of Phalanges Finger fractures are common in children and may present to Emergency Room as crush injuries, open fractures, subungual hematoma, mallet finger or boutonniere deformity. Mallet's Finger also know as baseball finger is injury to extensor tendon at distal interphalangeal joint often associated with fracture at distal phalaeux. The finger is bent at joint and cannot be extended. This is treated with splinting the distal phalanx in mild hyperextension. Boutonniere Deformity is injury to proximal phalanx due to direct blow leading to disruption of central slip of extensor tendon at PIP joint with volar subluxation of lateral filmes of tendon. The finger should be splinted in extension. Jersey Finger is avulsion of flexor digitorum profundus involving ring finger seen commonly in athletes with football or rugby sports. The patient is unable to flex the distal IP joint, has swelling tenderness at volar plate. Such injuries should be referred to hand surgeons. For most of the hands and finger injuries the hand should be splinted at 90 flexion at MP joint, and 15 flexion at interphalangeal joint. In summary the author has discussed the Common Guidelines for Management of Upper Extremity Trauma at Emergency Room with strong emphasis. Put on thorough physical examination, adequate x-rays and proper immobilization of the damaged extremity.

Bibliography
- Pediatric Emergency Medicine, 1992, Barkin.
- Physical Examination of Spines and Extremities, 1976, Stanley Hoppenfeld.